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A new stocking compression system with a low well-defined resting pressure and a high working pressure

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Abstract

Compression stockings should preferably apply the intended pressure regardless of leg shape and circumference. This may require custom fitting.[1] Today's sizing system is focusing on the exerted pressure at the ankle region. A ready-made stocking may therefore exert correct pressure at the ankle, but the pressure at the calf may be well exceeded due to the actual size of the calf, leading to a tourniquet effect, ischemia or even increased risk of thrombosis.[2] Even with a perfectly-fitted stocking, the problem with changes in leg circumference due to the increase/decrease in oedema is not resolved.[3,4] Stocking donning problems vary with compression class and elasticity of the material used. Added pressure over the calf area has been reported to improve venous pumping function more than graduated compression.[5,6] Adding stiffness over the calf area may also improve the pumping function.[7] Häfner et.al. stated that "Hemodynamically optimal compression products will make medical compression therapy an even more useful tool in the field of phlebology".[8] With new smart textiles, the pressure can be controlled.[9] The aim was therefore to evaluate a prototype of a stocking compression system with specified well-defined target resting pressure and supposedly high working pressure created by stiffness.

Materials and Methods

Included in this limited study were eight healthy subjects (5 women and 3 men). A novel compression system (Lundatex® Stocking System, PressCise, Sweden) consisting of a highly elastic stocking designed for 18 20 mmHg resting pressure without graduated pressure was used as a first layer. The stocking consisted of a patented smart textile with pressure specified to be well-defined regardless of leg circumference and shape. As a second layer, patches consisting of hook-material (similar functionality to Velcro) was applied. The second layer converts the system from elastic to stiff. The transformation of an elastic first layer into a stiff system has previously been studied with respect to interface pressure, stiffness, and haemodynamic effectiveness10. The patches were applied from about 5 cm above the malleoli to a point 3 cm below the top of the stocking. Interface pressure between stocking and skin were recorded (Picopress®, Microlab, Italy) unilaterally on all subjects. To evaluate the pressure profile as well as the pressure with respect to leg circumference, the interface pressure was measured at the B1 point which is defined as the point where the medial gastrocnemius muscle turns into the tendinous part and the C point at maximum leg-circumference. The static stiffness index (SSI)[11] was calculated. A Mann-Whitney U-test was used for comparisons and significance was set at $P<0.05$. Correlations are given with Pearson's r. Unless otherwise stated, all results are given as the mean and standard deviation (SD).

Results

The first layer, the stocking, with specified pressure 18-20 mmHg exerted well-defined target pressure (Table1). The pressure was uniform and showed low correlation to leg circumference ($r=0.2$) despite circumferences varying from 23 to 39.5 cm [Fig1]. A pressure increase was noted in supine position when patches were applied, 5 mmHg ($P<0.003$) at B1 and 6 mmHg ($P<0.001$) at C. With the second layer the system turned from an elastic system with low SSI (Table1) to a stiff product with high SSI (Table2).

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Discussion

The compression system applies a well-defined resting pressure regardless of the circumference of the leg, despite the fact that the same stocking was used on all subjects. This indicates that a limited number of stocking sizes may cover the whole range of leg sizes, and that custom fitting will not be required. A high working pressure was achieved by the stiff second layer. The low resting pressure and high working pressure gives the system a high SSI. The moderate increase in pressure when the patches were applied may be reduced by instructions to the applier of the system to avoid using extra stretch when putting on the patches. The subjects found the stocking easy to put on. A probable reason for this is the high elasticity of the stocking. There is reason to assume that the low resting pressure and high working pressure may be maintained over time even after reduction of oedema by opening and closing the front patch on the system, since this approach has successfully been used previously.[12] Future studies should investigate the pressure over time as well as the haemodynamic effectiveness of the system.

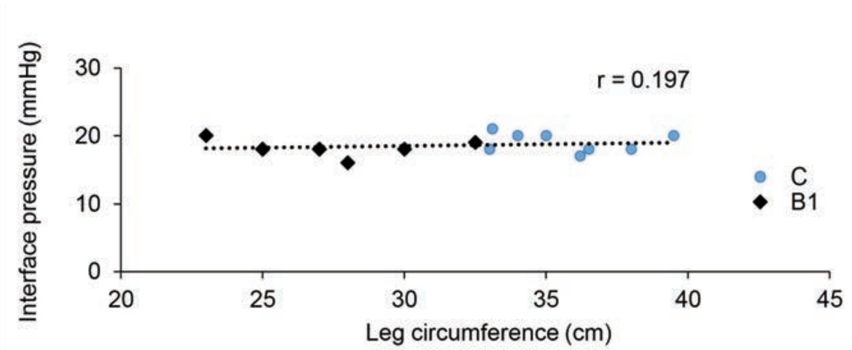

Figure 1. First layer-stocking only. Low correlation was found between Interface pressure measured in supine position and leg circumference.

Table 1. First layer-stocking only. Interface pressures (mmHg) in supine and standing position with SSI.

Sensor position	Supine		Standing		SSI	
	Mean	SD	Mean	SD	Mean	SD
B1	18	1.1	18	2.2	0.1	2.4
C	19	1.4	19	1.5	0.4	0.5

Table 2. System-stocking with patches. Interface pressures (mmHg) in supine and standing position with SSI.

Sensor position	Supine		Standing		SSI	
	Mean	SD	Mean	SD	Mean	SD
B1	23	3.3	44	14	21	13
C	25	2.3	40	9.2	23	7

Conclusions

This new prototype stocking compression system shows promising properties, with low defined resting pressure and high working pressure independent of leg circumference and shape, despite a minimum of measuring and fitting requirements.

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